Abstract—The Present investigation reports an optimized method fermenting Citric acid economically from Sucrose using Aspergillus Niger-NCIM 705. Experiments have been conducted on One-Factor-At-a-Time (OFAT) basis to evaluate the effect of the variables: Initial sucrose Concentration, Fermentation Temperature, Stirrer speed, oxygen flow rate, and pH on the amount of Citric acid produced, biomass generated and Sucrose consumed. Regression analysis carried out for the data reported that the fermentation temperature and oxygen flow rate were strongly influencing the yield of citric acid. Hence, experiments were again conducted for the two dominant variables. The yield of Citric acid obtained was developed as a function of fermentation temperature and oxygen flow rate and was optimized using Genetic algorithms (GA). The optimum values from experimental studies were found to be 32°C and 1.5 lpm with maximum citric acid of 58.70 g/l. Genetic algorithm reported 31.5°C and 1.0 lpm with maximum citric acid of 55.50 g/l. A confirmation test was also conducted with GA optimum value and found that the concentration of Citric acid was 55.0 g/l.

Keywords—Sucrose, Aspergillus Niger-NCIM 705, Fermentation, Citric acid, Operating conditions, Regression analysis, Optimization and Genetic algorithms.

I. INTRODUCTION

The Citric acid fermentation is a very complex process. Numerous events including growth limitations, enzyme activities, energy gain and energy state, intracellular acid accumulation, as well as uptake and transport systems display different optimal and regulation mechanisms, which are interconnected and interrelated in a synergistic mode [1]. Addition of methanol or ethanol greatly stimulates the production of citric acid by Aspergillus niger. Methanol on a volume basis is more effective than ethanol, which itself can be assimilated and converted into citric acid. The use of methanol to stimulate citric acid production should find application in the commercial production of this acid [2]. The effect of air saturation was significant, which would also influence the costs of an industrial fermentation process extremely. An optimum air oxygen saturation of 20% and temperature of 30-31°C were determined for the continuous citric acid secretion [3]. Enzyme activities as well as regulation and transport systems are in generally affected enormously by the temperature in microbial systems [4]. Citric acid is regarded as a metabolite of energy metabolism, of which the concentration will rise to appreciable amounts only under conditions of substantive metabolic imbalances [5]. Citric acid fermentation conditions were established during the 1930s and 1940s, when the effects of various medium components were evaluated [6]. The biochemical mechanism by which Aspergillus niger accumulates citric acid has continued to attract interest even though its commercial production by fermentation has been established for decades [7]. Although extensive basic biochemical research has been carried out with A. niger, the understanding of the events relevant for citric acid accumulation is not completely understood [8]. Genetic algorithms (GAs) are search algorithms based on the mechanics of natural selection and natural genetics [9]. Unlike classical search and optimization methods, GA starts its search with a random set of solutions, instead of a single solution. Each solution is then evaluated and assigned a fitness value. Termination condition is then checked. If the termination condition is not satisfied the set of solutions known as population, is modified using GA operators to form a new better fit population. This completes one generation and the process is repeated until a maximum number of generations are reached [10].

II. MATERIALS AND METHODS

A 1.2 liter capacity glass fermentor equipped with standard control and instrumentation shown in Fig.1 was used for the citric acid fermentation. The sterilized fermentor was placed in the main assembly and tube connections were given for water
and air supply. Then the sterilized medium containing vegetative inoculums was transferred to the fermentor from the conical flask after 24 hours of incubation. The power was switched on. The samples were collected for every 24 hours from the fermentor and analyzed titrimatically for citric acid produced.

III. RESULTS AND DISCUSSION

The experimental data on Initial sucrose Concentration, Fermentation Temperature, Stirrer speed, oxygen flow rate, and pH on the amount for Citric acid fermentation was regressionally analyzed to evaluate the effect of each variable. From the regression analysis, it was found that oxygen flow rate and fermentation temperature were influencing citric acid yields enormously. The effects of oxygen flow rate between 0.5-2.5 lpm and fermentation temperature between 28-32°C on citric acid production were studied experimentally maintaining remaining parameters constant at 150 g/l, 230 rpm and initial pH at 6.0. Maximum Citric acid production was found at 1.5 lpm of oxygen flow rates and 32°C fermentation temperatures.

A statistical model (eqn.1) was obtained for the data on two variables. Y=-1098978.57+126701190.88/x₁-7527715943.69/x₁^2+121028393215.86/x₁^3-920936624484.38/x₁^4+67.96*x₂-64.8*x₂^2+24.75*x₂^3-3.36*x₂^4 (1)

The above equation on optimization by Genetic algorithms gave the yields shown in table.1 and fig.2.

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Fig. 2. Optimal Citric acid concentrations generated by GA

GA predicted the maximum citric acid concentration of 55.50 g/l. at fermentation temperature of 31.5°C and oxygen flow rate of 1.0 lpm. A confirmation test was also conducted with GA optimum value and found the maximum concentration of Citric acid to be 55.0 g/l.

IV. CONCLUSIONS

The temperature and Oxygen influence the nutrient medium, biomass concentration and the Citric acid yield. The temperature and Oxygen should be optimum because higher temperatures and lower Oxygen can cause accumulation of other by-products, decrease in citric acid due to accumulation and denaturation of enzyme citrate synthase. Thus, at the optimum values 31.5°C and 1.0 lpm, the maximum citric acid concentration from GA was observed to be 55.5 g/l and from the experiment to be 55.5 g/l. The comparison of the results revealed that the experiment and GA values are in good agreement with each other.

REFERENCES

Neuro fuzzy modeling of rice husk combustion in Fluidised bed

Srinath. Suranani, Venkat Reddy. Goli

Abstract— This paper presents an adaptive-network based fuzzy system (ANFIS) for modeling the performance of fluidized bed combustor firing rice husk. Different ANFIS models have been constructed and tested in order to find the best ANFIS for modeling the performance of fluidized bed combustor (i.e. combustion efficiency). Two parameters have been considered in the construction and plausible ANFIS models. The type of membership function and the number of linguistic variables are two mentioned parameters. Based on the experimental data, the proposed model consists of three input variables such as feed rate, fuel particle size and air to fuel ratio were used to predict the combustion efficiency of the rice husk fired combustor. Six different models based on these inputs are defined. All of the trained ANFIS are then compared with respect to the Absolute percentage error. To meet the best performance of the intelligent based approaches, data are pre processed (scaled) and finally out puts are post – processed (returned to its original scale). The ANFIS model is capable of dealing with both complexity and uncertainty in the data set.

Keywords— Adaptive neuro fuzzy inference system (ANFIS), Neural networks, Fuzzy-logic, Combustion efficiency.

I. INTRODUCTION

Energy is vital for the social and economic development of any nation. The world energy demand is increasing very rapidly with development of civilization and growing industrialization. The energy requirement of India is expected to grow at 5.6 - 6.4% per year in coming years which means around four fold increases in energy requirement over the next 25 years. Coal is most important and abundant fossil fuel in India and accounts for 55% of India’s energy need, whereas 30% of the requirement is met by petroleum products. A large population of India in the rural areas depends on the traditional sources of energy such as firewood, animal dung and agricultural residues consisting mainly of rice husk, saw dust, groundnut shell, coconut coir, cotton flower shell, etc.

Biomass is an important source of energy in tropical countries, particularly in South and Southeast Asia, accounting for some 40% of the total regional energy consumption. Worldwide, biomass is the fourth largest energy resource after coal, oil, and natural gas [11]. Energy derived from the biomass is called bioenergy. These biomass feed stocks can be used for power generation applications. In view of this, a variety of processes exists for biomass conversions. The most used of these are thermal conversions, bio-chemical and chemical conversions and direct combustion. The thermal conversion processes consist of fast and slow pyrolysis, biomass gasification and fluidized bed combustion.

Fuel flexibility, excellent solid–gas mixing, temperature homogeneity and effective emission control makes the fluidized-bed combustion technology [5] the most efficient and environmentally friendly technology for conversion of energy from various biomass fuels, particularly, from agricultural residues sustainably produced on a large scale.

The performance of fluidized bed combustor i.e. the efficiency of carbon conversion may greatly depend on the movement of solids and gas in bed and freeboard. In addition to mixing there are several other factors influencing conversion, such as the residence time in the bed. The conversion in gas–solids fluidized bed combustors has been observed to vary from plug flow, to well below mixed flow. In fluidized bed combustion process internally lot of changes in terms of composition, temperature, reactions and flow rate occur. The process of developing model equations is very complex, and difficult to visualize. Multiple differential equations with strong cross influences are the norm. Hence an attempt has been made to model the FBC process using black-box approach. An often used approach for black-box models are Artificial Neural Networks [8][2]. Neuro-fuzzy modeling refers to the way of applying various learning techniques developed in the neural network literature to fuzzy modeling or a fuzzy inference system (FIS)[1]. Neuro-fuzzy systems, which combine neural networks and fuzzy logic, have recently garnered a lot of interest in research and application. The neuro-fuzzy approach [7] has added the advantage of reduced training time, not only due to its smaller dimensions but also because the network can be initialized with parameters relating to the problem domain. Such results emphasize the benefits of the fusion of fuzzy [4]and neural network technologies as it facilitates an accurate initialization of the network in terms of the parameters of the fuzzy reasoning system. Various types of